Microbiology

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Curved bacteria infect GI tract and mycoplasma

1. Campylobacter

- ***Characteristics:***
  - ✓ Small, *motile*, curved, *gram-negative rods* (0.2 to 0.5 μm wide and 0.5 to 5.0 μm long).
  - ✓ *Microaerophilic* growth conditions (5-7% oxygen and 5-10% carbon dioxide).
  - ✓ Grows better at 42°C than at 37°C.
  - ✓ Expresses lipooligosaccharides (LOSs), lacking O-antigen in LPS.
  - ✓ The organisms are killed when exposed to gastric acids, so conditions that decrease or neutralize gastric acid secretion favor disease
  - ✓ C. jejuni GI disease characteristically produces histologic damage to the mucosal surfaces of the jejunum and other parts of the intestine

- ***Pathogenesis:***
  - ✓ Infections are often *zoonotic*, with contaminated poultry being a primary source
  - ✓ Uncommon for the disease to be transmitted by food handlers
  - ✓ C. jejuni is *the most common* cause of bacterial gastroenteritis, presenting as acute enteritis with diarrhea (which may be bloody), fever, and severe abdominal pain.
  - ✓ *Complications* include Guillain-Barré syndrome and reactive arthritis, likely via molecular mimicry.
  - ✓ *Diagnosis*: Based on selective growth, typical morphology, oxidase, and catalase tests.

2. Helicobacter

- ***Characteristics:***
  - ✓ Spiral-shaped, *gram-negative rods* resembling Campylobacter.
  - ✓ Highly *motile* (corkscrew motion) and urease-producing.
  - ✓ Growth requires a complex medium in *microaerophilic* conditions.
  - ✓ H. pylori adheres to gastric mucosa and is not usually found in stool or blood.
  - ✓ H pylori use their motility, chemotaxis, urease production, and other mechanisms to *adapt* to the acidic conditions of the stomach and colonize a narrow protected niche near the surface of epithelial cells
  - ✓ Humans are the primary *reservoir* for H. pylori, and colonization is believed to persist for life unless the host is specifically treated.

- ***Pathogenesis:***
  - ✓ Primarily *transmitted* via the fecal-oral route.
  - ✓ Colonization persists for life unless treated.
  - ✓ Urease, mucinase, phospholipases, and vacuolating cytotoxin A (VacA) contribute to tissue damage.
  - ✓ Cytotoxin-associated gene (cagA) disrupts epithelial cell cytoskeletal structure.

- ***Diseases***:
  - ✓ *Colonization* with H. pylori invariably leads to gastritis
  - ✓ The *acute phase* of gastritis is characterized by a feeling of fullness, nausea, vomiting, and hypochlorhydria.
  - ✓ Can evolve into *chronic gastritis*, with disease confined to the gastric antrum or involve the entire stomach
  - ✓ Chronic gastritis will progress to develop peptic ulcers. The ulcers develop at the sites of intense inflammation, commonly involving the junction between the corpus and antrum (*gastric ulcer*) or the proximal duodenum (*duodenal ulcer*).

- ✓ Causes gastritis, peptic ulcers (H. pylori is responsible for 85% of gastric ulcers, 95% of duodenal ulcers), and increases the risk of gastric cancer and MALT lymphoma.
- ✓ **Diagnosis**: Histology of gastric biopsy, stool antigen tests, or non-invasive immunoassays.

➢ Nobel Prize: In 2005, Marshall and Warren received the Nobel Prize for discovering H. pylori's role in gastritis and peptic ulcers.

3. Vibrio

➢ ***Characteristics***:

- ✓ Gram-negative, *facultatively anaerobic*, fermentative *rods* characterized by a positive oxidase reaction and the presence of polar flagella. [Lipopolysaccharides consisting of lipid A (endotoxin), core polysaccharide, and an O polysaccharide side chain. The O polysaccharide is used to subdivide Vibrio species into serogroups, V. cholerae O1 and O139 produce cholera toxin and are associated with epidemics of cholera. Other strains of V. cholerae generally do not produce cholera toxin and do not cause epidemic disease]
- ✓ Require sodium chloride for growth (*halophilic*) and tolerate a wide range of temperatures (14°C-40°C) and pH (6.5-9.0) but are susceptible to stomach acids.
- ✓ All species of Vibrio require sodium chloride (*NaCl*) for growth. Most species are halophilic ("salt-loving").
- ✓ Vibrio species, including V. cholerae, grow naturally in *estuarine and marine environments worldwide.*
- ✓ Pathogenic vibrios can also flourish in waters with chitinous *shellfish*

➢ ***Transmission***:

- ✓ Cholera is spread by contaminated water and food rather than direct person-to-person spread, because a high inoculum (e.g., >108 organisms) is required to establish infection in a person with normal gastric acidity.
- ✓ Cholera is usually seen in communities with poor sanitation

➢ ***Diagnosis***:

- ✓ Immunoassays for the detection of cholera toxin or the O1 and O139 lipopolysaccharides are used for the diagnosis of cholera in endemic areas.

➢ ***Pathogenesis***:

- ✓ V. cholerae is the primary pathogen, producing cholera toxin, which leads to severe diarrhea.
- ✓ Transmission is mainly through contaminated water or food.
- ✓ Cholera causes "*rice-water*" stools, and severe dehydration can lead to hypovolemic shock.

➢ ***Virulence Factors***:

- ✓ The cholera toxin is a complex A-B toxin. The active portion of the A subunit is internalized and interacts with G proteins that control adenylate cyclase, leading to the catabolic conversion of adenosine triphosphate (ATP) to cyclic adenosine monophosphate (cAMP). This results in a hypersecretion of water and electrolytes.
- ✓ The resulting severe fluid and electrolyte loss can lead to dehydration, painful muscle cramps, metabolic acidosis (bicarbonate loss), and hypokalemia and hypovolemic shock (potassium loss), with cardiac arrhythmia and renal failure. Cholera toxin increases cAMP, leading to fluid and electrolyte loss.
- ✓ Mortality rate is high without treatment but low with prompt fluid and electrolyte replacement.

4. Anaerobic Gram-Negative Rods

- ***Key Species:***
  - ✓ Bacteroides, Fusobacterium, Parabacteroides, Porphyromonas, and Prevotella.
  - ✓ Bacteroides species are pleomorphic and resemble a mixed population in Gram stains.
  - ✓ Growth is stimulated by bile, and Bacteroides have a typical gram-negative cell wall with a polysaccharide capsule.

- ***Pathogenesis:***
  - ✓ Bacteroides fragilis can cause infections by spreading from mucosal surfaces to sterile tissues through trauma or disease.
  - ✓ Infections are usually polymicrobial.
  - ✓ Common infections include respiratory tract infections, intra-abdominal infections, bacteremia, and skin/soft-tissue infections, especially in immunocompromised patients.
  - ✓ *Bacteroides fragilis Toxin:* Causes self-limited watery diarrhea by stimulating chloride secretion.
  - ✓ Anaerobic infections are often associated with chronic sinusitis, ear infections, and periodontal diseases.

5. Mycoplasma

- ***Characteristics:***
  - ✓ Smallest free-living bacteria, *lacking a cell wall,* with sterols in their cell membranes.
  - ✓ *Pleomorphic* shapes ranging from coccoid forms (0.2-0.3 μm) to rod shapes (0.1-0.2 μm wide and 1-2 μm long).

- ***Pathogenesis***:
  - ✓ M. pneumoniae causes tracheobronchitis and primary atypical pneumonia worldwide.
  - ✓ M. genitalium is linked to nongonococcal urethritis and pelvic inflammatory disease.
  - ✓ Diagnosed by PCR amplification of species-specific gene targets, as traditional Gram staining is not effective.
  - ✓ *Antibiotic Resistance*: Mycoplasmas are resistant to antibiotics that target cell wall synthesis (e.g., penicillins, cephalosporins).

Questions

1) **Which of the following organisms is the most common bacterial cause of gastroenteritis?**
   - **A.** Vibrio cholerae
   - **B.** Campylobacter jejuni
   - **C.** Helicobacter pylori
   - **D.** Salmonella Typhi

2) **Case Scenario: A patient develops profuse, watery "ricewater" stools after consuming contaminated water during a flood. What is the most likely causative agent?**
   - **A.** Campylobacter jejuni
   - **B.** Vibrio cholerae
   - **C.** Helicobacter pylori
   - **D.** Salmonella Enteritidi

3) **Which of the following is the primary virulence factor associated with Vibrio cholerae infections?**
   - **A.** Cholera toxin
   - **B.** Urease enzyme
   - **C.** Shiga-like toxin
   - **D.** Lipopolysaccharide (LPS)

4) **What enzyme produced by Helicobacter pylori allows it to survive in the acidic environment of the stomach?**
   - **A.** Catalase
   - **B.** Urease
   - **C.** Coagulase
   - **D.** Oxidase

Answers

1. Which of the following organisms is the most common bacterial cause of gastroenteritis?
   - B. Campylobacter jejuni

2. Case Scenario: A patient develops profuse, watery "ricewater" stools after consuming contaminated water during a flood. What is the most likely causative agent?
   - B. Vibrio cholera

3. Which of the following is the primary virulence factor associated with Vibrio cholerae infections?
   - A. Cholera toxin

4. What enzyme produced by Helicobacter pylori allows it to survive in the acidic environment of the stomach?
   - B. Urease

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